Remarks

The present invention relates to a monitoring method and apparatus for performing an unmanned vertical stereoscopic observation by means of one or more pairs of imagers. Both imagers of each pair are positioned along a common vertical line, are vertically spaced, and capture a same object at a different angle of view. Thus the movement of an object that moves directly towards the imagers can be detected by virtue of the vertical spacing between the two imagers of a pair; however, such movement would not be detectable if the two imagers of a pair were horizontally spaced. The field of view of one imager at least partially overlaps the field of view of the second imager of the pair, to enable the determination of the distance to the observed objects from the imagers, the evaluation of the path and size of each observed object, and the classification of type and degree of danger of each observed objects by processing real-time photographic data obtained from the stereoscopic observation. An indication is provided when one or more observed objects is approaching a controlled space and has been classified as having a sufficiently high degree of danger so as to be liable of damaging an authorized body within the controlled space.

Vertical stereoscopy, as opposed to horizontal stereoscopy, provides the following advantages:

1. The capability of detecting very slow radial movement, such as that of a person that is crawling, or of completely static targets.
2. Improved target differentiation with respect to danger parameters of observed object parameters, such as range, size, and direction of motion, due to a reduced sensitivity to vibration.
3. Improved stability and alignment as a result of reduced mechanical stresses since the provision of an arm supporting an imager is unnecessary, while enabling calibrated rotation of one or two imagers about the vertical line on which they are mounted.
4. A reduction in the false alarm rate due to the improved stability.

5. The capability of being mounted on a wall or fence due to the vertical separation of both imagers of a pair. If both imagers of a pair were horizontally separated, the wall or fence would split the view, at least for a great part of the field of view.

As both imagers of each pair are optical imagers and/or FLIR thermal imagers, the apparatus may be multispectral, in order to increase the probability of detection, even during difficult weather conditions, such as during fog and rain, or during nighttime. The combination of imagers that provides an optimal detection performance during the given weather conditions can be automatically selected and switched at any moment by means of dedicated software. The apparatus is therefore able to cope with jamming or camouflage, since what may be hidden in one spectral band can be detected in another band, and by image fusion, this kind of jamming or camouflage can be overcome.

The apparatus can also simultaneously process in real-time data related to a plurality of targets. The system can also disregard, by means of a software based learning feature, various types of movements that are characteristic of a low degree of danger, such as swaying branches and sea waves. This feature additionally reduces the false alarm rate. The false alarm rate is even further reduced by ensuring that a suspected object is observed by both imagers of a pair.

The examiner has rejected independent claims 1 and 28 as being anticipated by Monroe (US 6,979,183). The applicant respectfully disagrees with this contention.

Monroe discloses a surveillance system comprising a plurality of sensor appliances such as megapixel digital cameras adapted to be connected to a network based server for monitoring, logging, and transmitting data to the server in order to permit comprehensive surveillance of a predetermined area. GPS

dispatching is used to locate and alert personnel as well as to indicate the location of an event.

In contrast to the present invention, Monroe fails to teach, or even to suggest, that stereoscopic observation of a controlled space or sections thereof is carried out by means of the digital cameras. Surveillance by means of a plurality of digital cameras does not constitute a stereoscopic observation, which requires a pair of imagers to provide an overlapping field of view, to be stable, and to be well aligned at all times. Fig. 49 of Monroe, for example, illustrates that each camera monitors a different sector of the controlled space. Monroe certainly neither teaches nor suggests vertical stereoscopic observation whereby both imagers of a pair are positioned along a common vertical line and capture a same object. The passage indicated by the examiner does not teach that both imagers of a pair are positioned along a common vertical line.

Since the cameras of Monroe do not carry out stereoscopic observation, the system of Monroe therefore cannot jointly process the real-time photographic data obtained from the stereoscopic observation with respect to the angle of view of each of the imagers, as recited in claims 1 and 28 of the present invention. Also, the system of Monroe cannot classify a type and degree of danger of each of said observed objects by jointly processing the real-time photographic data obtained from said stereoscopic observation with respect to the angle of view of each of the imagers and stored danger parameters, as recited in claims 1 and 28 of the present invention.

Monroe does not teach or suggest that the size of each observed object can be evaluated, as recited in amended claims 1 and 28 of the present invention. The system of Monroe therefore cannot classify a type and degree of danger of each of said observed objects by jointly processing the real-time photographic data obtained from said stereoscopic observation with respect to

the angle of view of each of the imagers, path and size of each observed object, and stored danger parameters.

Although Monroe teaches the use of an imager in total darkness, the nighttime imager of Monroe requires external illumination by means of an infrared LED illuminator and an image intensifier. The FLIR imager recited in amended claims 1 and 28 of the present invention, in contrast, does not require any external illumination or an image intensifier since it detects thermal energy and interfaces with a digital image processor to improve the image quality. Thus the apparatus of the present invention by employing one or more FLIR imagers can also detect objects during difficult weather conditions, such as during fog and heavy rain. The cameras of Monroe cannot detect objects when exposed to fog and heavy rain, and therefore are not suitable for the outdoor monitoring of an envronment.

It is therefore clear that Monroe does not anticipate amended claims 1 and 28.

As the digital cameras of Monroe cannot carry out stereoscopic observation, the surveillance system is based on video motion detection (VMD), and a suspected object can be detected only when there is a change in the image. By virtue of the stereoscopic observation carried out by the imagers of the present invention, very slow moving or completely static intruders can be advantageously detected.

Milgram et al (US 5,175,616) discloses a system which synchronously superimposes a virtual, stereographic pointer video signal onto a composite standard video signal of a remote environment so as to allow the two signals to be displayed together as a single combined video signal on a single viewing screen. An operator is therefore able to perceive on a single video monitor a three dimensional image of the remote visual surroundings and to manipulate the

stereographic pointer within that image. The standard video signal is generated by means of right and left cameras for producing right and left video images, respectively. Stereoscopic shuttering spectacles, for use by the observer, separate odd and even raster scan field video images displayed on the video screen into left and right eye images, respectively, to allow the observer to perceive three dimensional images on the viewing screen. An interactive camera alignment control system dynamically configures the separation and convergence angle of the pair of cameras so that the point of convergence of the cameras will be as close as possible to the center of an observer's interest within a video scene produced by the cameras being viewed.

Although Milgram et al teaches a system for performing a stereoscopic observation, the system of Milgram et al is adapted to perform a horizontal stereoscopic observation by means of right and left cameras, and does not teach or suggest performing a vertical stereoscopic observation, as recited in amended claims 1 and 28 of the present invention. The disadvantages of a horizontal stereoscopic observation with respect to a vertical stereoscopic observation have been clearly set forth above, for example reduced calibration of the imagers, leading to a corresponding reduction in target differentiation.

Additionally, the system of Milgram et al is dependent on an observer to indicate where in the three-dimensional environment he is interested in focusing. The operator then performs an interactive operation in response to the indicated focus of attention. In contrast, the apparatus of the present invention is used for continuous and reliable monitoring of an environment and is not dependent on human perception to notice dangerous objects. The monitoring method of the present invention is completely automatic, the stereoscopic observation being unmanned and capable of monitoring of an environment both during daytime and nighttime hours, and in all types of weather conditions, when a human operator may not be alert or not able to notice dangerous objects. When an observed object approaching the controlled space is classified as being dangerous, an

indication such as an alarm is automatically generated so than an action that will eliminate the danger of collision, intrusion or damage may be taken.

Additionally, the sensors of the right and left cameras are positioned to generate intersecting epipoles, or projections of the line connecting the focal point and point of interest onto the image plane of the other camera, as illustrated for example in Fig. 5B of Milgram et al, in order to focus on relatively close objects. In contrast, the epipoles of both imagers of a pair of the present invention are set at infinity, in order to detect distant objects and classify their type and degree of danger. The algorithm for jointly processing photographic data generated from intersecting epipoles is significantly more complicated than that for jointly processing photographic data generated from epipoles set at infinity, and the computer resources needed by the apparatus of the present invention for jointly processing photographic data are significantly less than those needed by the system of Milgram et al. The computing time of the apparatus of the present invention for jointly processing photographic data is therefore significantly less than the computing time of the system of Milgram et al for jointly processing photographic data.

The combination of Monroe and Milgram et al would lead to a surveillance system for performing close range, illuminated horizontal stereoscopic observation, teaching away from the monitoring method of the present invention whereby long range vertical stereoscopic observation is carried out both during daytime and non-illuminated nighttime or difficult weather conditions.

Lipton (US 6,954,498) discloses a method for video processing with respect to those applications such as entertainment, teleconferencing, video post-production, and gaming, whereby an object of interest is extracted from a video stream. The object from the video stream is analyzed and manipulated to obtain a synthetic character. A virtual video is assembled using the synthetic character.

Lipton fails to teach or suggest a monitoring method for performing a vertical stereoscopic observation of a controlled space and for classifying the type and degree of danger of each observed object, as recited in amended claims 1 and 28 of the present invention. Lipton is therefore incapable of providing target differentiation.

Goldenberg et al (US 6,113,343) discloses a robot for use in hazardous environments, and particularly for explosives disposal, includes a wheeled platform carrying a winder mechanism which ensures that the remote control cable will not be fouled by the robot or its attachments. Once again, Goldenberg et al fails to teach or suggest a monitoring method for performing a vertical stereoscopic observation of a controlled space and for classifying the type and degree of danger of each observed object, as recited in amended claims 1 and 28 of the present invention.

The combination of Monroe and one or more of the cited references would therefore teach away from the present invention.

As the rejections to the present invention have been overcome, the applicant respectfully requests that the present invention be allowed.

Respectfully submitted,
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